INTERCANTHAL DISTANCE IN SOUTH INDIAN POPULATION

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DEPARTMENT OF ORAL AND MAXILLOFACIAL SURGERY

CERTIFICATE

This is to certify that this dissertation entitled **"Intercanthal Distance In South Indian Population"** is a genuine work done by **Dr. C. Binila Asir** under my guidance during her post graduate study period between 2008-2011.

This Dissertation is submitted to THE TAMIL NADU DR. M.G.R. MEDICAL UNIVERSITY in partial fulfillment for the Degree of **MASTER OF DENTAL SURGERY IN ORAL AND MAXILLOFACIAL SURGERY, BRANCH III.** It has not been submitted (partial or full) for the award of any other degree or diploma.

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AIM

Our aim of the study is to determine the following:

- To determine the Intercanthal distance for a specific population
- To formulate a standard value for the Intercanthal distance in a healthy South Indian population.
- To establish distance between the two medial inner canthus so that it proves to be a significant aesthetic standard for posttraumatic orbital reconstruction, ophthalmologic surgeries, and in distinguishing normal from craniofacial anomalies and also in various other applications in medicine like construction of spectacle frames in the field of optometry, forensic applications, etc…

OBJECTIVE

The role played by the orbit in maxillofacial injuries [especially in road traffic accidents] and the deformities occurring in and around this region has provoked us to establish a standard norm for the specific parameter of Intercanthal distance .

Keeping this objective in mind, an aesthetic norm has been created by us in this study in the perspective of its benefit in ophthalmic and plastic reconstructive surgeries, post traumatic orbital reconstructive surgeries, correction of certain craniofacial anomalies, orthognathic surgeries, etc and also its various other applications in the field of medicine like construction of spectacle frames in optometry.

Also the lack of literature support regarding the soft tissue reconstruction in and around the orbit which is the hallmark of beauty in a human face led us to the path of journey towards finding an aesthetic norm which can act as a basement guide for any surgeries in and around the medial side of the orbit.

MATERIALS AND METHODS

Prospective study was designed to create a standard parameter for the **INTERCANTHAL DISTANCE (ICD)** in a South Indian Population. The study was done in Rajas dental college and hospital, Kavalkinaru, Tamilnadu.

Criteria for selection of population:

Inclusion criteria:

Total of 665 samples were taken including both males and females.

Males	:	301
Females	:	364
Age criteria	:	17- 30 years
State	:	Tamilnadu And Kerala

Exclusion Criteria:

Samples who had

- Ophthalmology oriented surgeries,
- Previous history of facial trauma, involving NOE complex
- Craniofacial congenital and hereditary anomalies
- Ocular diseases
- Developmental disability

Samples belonging to Mixed ethnic groups

METHODS:

The measurements were made using a DIGIMATIC VERNIER CALIPER. The specifications are:

Code No	:	500-144
Measuring range	:	6 inches / 0-150 mm
Resolution	:	0.0005 inches /0.01 mm
Instrumental Error	:	$\pm$ 0.001 inches / $\pm$ 0.02 mm
Battery	:	SR 44 with approximately 20,000 hrs life [silver oxide cell]

ARMAMENTARIUM

DIGITAL VERNIER CALIPER (FIG. 1 AND 2)

Parts :

- Internal jaws
- External jaws
- Metric /inch button
- Locking screw
- LCD display
- Scale
- Power On / Off
- Zero setting
- Depth measuring blade

METHOD OF MEASUREMENT

The subject and the operator should be seated in the same plane at the same level at a relaxed position. In females, hair was tucked up, and all the samples had no make-up[18]. The same room with consistent lighting was used throughout the study. Individuals were adviced to close their eyes while measuring. (Fig. 3)

Display on the vernier caliper is turned on with the on/off button. The external jaws should then be brought together until they touch and the zero button should be pressed. Each limb of the external jaws are placed one on each side of the medial angle of the palpebral fissure [endocanthion][50] by moving the jaws apart slowly and stabilize the face by taking rest on the zygomatic bone. (Fig. 4) Caliper is placed without structural distortion[40]. Then the measurement showed on the LCD display is noted down. The distance is measured twice for each sample for improving the accuracy of measurement.

The same procedure is repeated for every other sample.

REVIEW OF LITERATURE

RICHARD .A. GAARD [1961][48] studied cases of craniofacial deformities with hypertelorism in California, with his specific point of interest towards ocular hypertelorism of GREIG, and states that canthus can be used as reference points for an accurate measurement of distance between the orbits rather than the pupils. The upper limit of values for normal and hypertelorism cases were found to be 38 and 42mm respectively.

J.C. MUSTARDE [1963][42] in his study on the surgical options for epicanthus and telecanthus, in a group of cases in Glasgow, states that epicanthal folds in the vicinity of the medial canthi disappeared by the age of 11 years, and diagnosed an invariably large Intercanthal distance in patients with isolated cleft lip. Epicanthal folds disappeared early in girls compared to boys. The credit of naming the far – apart canthi as epicanthus goes to him.

M.F. STRANC [1967][52] while rationalizing the primary treatment of naso- ethmoid injuries with lateral separation of the medial canthal ligament in a Caucasian group aged 16- 64 years, diagnosed traumatic telecanthus in about all cases of nasal fractures with / without Lefort II. He states that restoration of intercanthal distance should take priority over facial contours and external nose.

M. F. STRANC [1970][53] while studying the pattern of lacrimal injuries in nasoethmoid fractures and its intimate relationship to the inner canthus in a group of patients in Middlesex, found the maximum and minimum Intercanthal distance in injuries to be 5.0cm, and 3.5cm respectively. He signifies the importance of accurate fixation of medial canthal ligament for preserving the patency of lacrimal duct.

RICHARD .C. JUBERG [1975][49] while studying the normal values for Intercanthal distance in American Blacks in Louisiana University, found the values of Black boys and girls to exceed that of Whites and points out its relevance to diagnosis of various syndromes.

C. WALTER [1976][56] in his study on discussion of the problems related to reconstruction in medial lid angle in Germany, has taken a rough estimate of the nasal alar width to be the width of the normal Intercanthal distance due to lack of an ideal norm for this parameter and establishes the importance of proper Intercanthal distance in secondary reconstruction in midface trauma.

L.M. IREGBULEM [1978][25] in his study on midline clefts of upper lip in Nigeria found increased Intercanthal distance of about 39mm to be one of the salient features of median cleft face syndrome.

HANS PETER .M. FREIHOFER [1980][23] in their study in a specific population in Switzerland has found the normal thickness of soft

tissue between the inner canthus and the anterior lacrimal crest to be 5-7 mm with the aim of correlating it to the Intercanthal distance. The mean Intercanthal distance for normal males and females were 31.7 and 30.8 mm respectively. Unilateral and bilateral cleft patients had 33.4 mm and 36.0mm respectively.

GEORGE .A. WESSBERG [1981][17] in his study on the ophthalmologic considerations in maxillofacial trauma in a hospital in USA, reviewed the anatomical location of the orbit with focus on the high incidence of orbital involvement in facial injuries.

JORGE .M. PSILLAKIS, [1981][30] while working out few cases of orbital hypertelorism in a hospital at Brazil, signifies the importance of achieving an aesthetically normal appearance of face and has formulated a new technique of craniofacial osteotomy to avoid recurrence of widening of Intercanthal distance in children operated during the growth period.

JAIRUP SINGH [1983][27] for the first time studied the normal values of inner canthal distance, outer canthal distance and interpupillary distance in Indian population in Human Genetics Laboratory, Amritsar, and found the mean values to be 3.15 $\pm$ 0.2445 cm, and 3.09 $\pm$ 0.2862 cm for males and females respectively.

CHARIS IOANNIDES [1984][6] in his study on the incidence of fractures due to midface trauma at Netherlands, found the percentage of soft tissue facial injuries to be high and ocular related features were most prominent and retained the highest percentage.

HANS PETER .M. FREIHOFER [1984][21] in his study on assessing the lattitude and limitation of midface movements during orthognathic surgeries in the Department of Oral and Maxillofacial Surgery at Netherlands, says that bony cuts of Lefort osteotomies depends on the position of canthus. Also, correction of telecanthus is possible in all Lefort I, II, and III osteotomies and found the results to be stable.

RODRIGUEZ R. L. [1988][47] in a study at Newyork reviewed the current concepts of medial canthal tendon reconstruction after cancer resection, traumatic injuries, and after cranial procedures and specifies the importance of rapid reduction of bony fragments prior to medial canthal tendon reconstruction.

CHARIS IOANNIDES [1988][9] while studying the incidence of ocular injuries in orbital injuries in a few patients at Newyork, found an excessive Intercanthal distance to be the second most highest ocular related lesion sustained.

LESLIE .G. FARKAS, [1989][34] in his study on finding out the differences between the anthropometric and cephalometric findings in orbital hypertelorism patients found that medial bony wall of orbit is 5.4-7.5 mm medial to the endocanthion in normal patients and was about 10.8 mm in mild, 11.5mm in moderate, and 14.2mm in severe hypertelorism cases.

WALTER .K.MURPHY [1990][57] in a study on black population in the Medical College of Virginia, quoted the mean value for Intercanthal distance for men & women to be 35.7$\pm$ 3.7mm and 33.1 $\pm$ 2.3 mm respectively.

HAROLD .E. COOK [1990][12] in a retrospective study on the incidence of midfacial fractures in a hospital at Dallas, found that Naso-orbito- ethmoidal complex fractures accounts for about 39% which is the second highest type of injury and the age group retaining the highest percentage of injury was 21-30 years.

BARRY .L. EPPLEY [1990][3] in his review on various approaches for orbital skeleton and periorbital structures states that Lynch approach provides excellent approach to the medial orbit although its not an aesthetically favourable approach and can be used for trauma, aging, tumours and aesthetic bone contouring.

WICHIT THARANON [1991][55] in a study done in the Texas university at Dallas, states that preinjury and post injury intercanthal distance was measured using photographs and was used to rule out traumatic telecanthus in individuals who have greater than average intercanthal distances prior to trauma.

PREMA LEKSHMI NARAYANA [1991][45] in a study done in a Child health hospital at Chennai have formulated the inner canthal distance values in a South Indian population for the age group between birth to 11 years and has found the maximum value to have been achieved at the age of 3 years which was around 3.1cm after which there was no growth.

JULIE .R. QUANT [1992][31] has done a study in Optometry section in HongKong and found the values of Interpupillary distance, Interorbital distance and Intercanthal distance in a Chinese population. The Intercanthal distance values were found to be 35.93 and 35.13mm for males and females respectively because its an important diagnostic tool in several systemic syndromes associated with craniofacial abnormality either congenital or traumatic.

MICHAEL .E. KOURY [1992][40] in his review of study done by Farkas which was a substantial contribution to anthropometic measurements in adult Whites, formulated the guidelines for maxillofacial

aesthetics in maxillofacial region and found the intercanthal width to be 34% of biocular width, 25% of bizygomatic width, and fissure width to be 95% of intercanthal width.

LESLIE .G. FARKAS [1992][35] in a study done on age related changes in intercanthal width in North American Caucasians states that Intercanthal distance reaches the stage of complete maturation by the age of 11 years for males and 8 years of age for females.

ROBERT .D. MARCIANI [1993][46] formulated the principles of management of craniofacial trauma and rounded medial canthal region is one of the finding suggestive of craniofacial trauma and implies that functional repair of the orbits is the key to cosmetic rehabilitation of midface.

KAIMBO DK. [1994][32] measured the values of Intercanthal distance in healthy Zarian children and valued as 27.4 $\pm$ 2.7, 29.7 $\pm$ 3.1, 30 $\pm$ 2.4, 32.3 $\pm$ 3.1, for the age groups 2 ½ - 6 yrs, 7-10, 11-14 & 15-18 yrs, respectively.

M.A.W. MERKX [1995][39] in a prospective study done at University Hospital St. Radboud, Nijmegen, at, The Netherlands for assessing the aesthetic results of primary treatment of telecanthus after Naso-orbito-ethmoidal fractures, postoperative transverse Intercanthal distance was measured with a caliper by placing the legs of the caliper on

the medial canthi and error was not higher than 0.5 mm and assessed the type of injury, fixation technique, and the time interval between injury and repair using three way analysis [ANOVA].

HANS PETER .M. FREIHOFER [1995][22] in a prospective study done at The University Hospital, at Nijmegen, The Netherlands for assessing the need for secondary traumatic periorbital reconstruction, infers that after repositioning of the medial canthus, it seemed not to be absolutely necessary for the Intercanthal distance to be below 36mm in order to be rated good. But at the end of direct or indirect canthopexy, the Intercanthal distance values of 33 mm after direct and 31 mm after indirect canthopexy were decided as the upper limit of values.

BEAT HAMMER [1995][4] in a review of study of skeletal correction of post traumatic deformities summarizes the need for special attention to be paid for placement of medial canthal ligaments during secondary reconstruction since even minor malposition are easily visible. Rearrangement of soft tissue envelope with its landmarks is one of the basic elements of corrective surgery according to him.

M.M. COHEN [1995][11] in his review of study on hypertelorism suggested that increase in the Interorbital distance is due to pneumatization of paranasal sinuses, and Interorbital growth is 50% completed by 3 years of age.

KAIMBO WA KAIMBO .D [2000][33] compared the values of Intercanthal distance in healthy children in Kinshasa to that of children with sickle cell disease and found the values to be identical.

CEM EVEREKLIOGLU [2001][7] in a study done at Turkey for creating normal values for benign Macrocephalic Healthy children found the values of Intercanthal distance to be 31.90 $\pm$ 2.41mm, & 31.45 $\pm$ 2.65 mm for boys and girls respectively, and narrates the usefulness of these values in early identification of craniofacial syndromes, congenital or post traumatic telecanthus, epicanthus and hypo - hypertelorism.

CEM EVEREKLIOGLU [2001][8] in a study done in a Turkish elementary school population for finding the values of Intercanthal distance in an idiopathic benign macrocephalic healthy children population, found the inner Intercanthal Distance of children with hypertelorism to be larger [3.38 $\pm$ 0.23cm] than those of children with benign macrocephaly [3.17 $\pm$ 0.25 cm].

FERRARIO [2001][15] studied the sex related linear and angular dimensions of orbital region and growth changes between adolescence and mid adulthood and found that the linear distances were greater in males than females .

BRETT .J. KING [2OO3][5] in studying a group of population belonging to Caucasian, American, Hispanic and Asians for comparison

of values of Intercanthal distance found that Asian population [35.6mm] has widest Intercanthal distance followed by Hispanic, African-American & Caucasian population and is a significant aid in the treatment of patients with severe maxillofacial injuries.

GUPTA .V.P. [2003][19] in a study done in a healthy Indian population for establishing values for Inner Intercanthal distance, Interpupillary distance, Outer Intercanthal Distance in a normal Indian population aged 3-80 years found the values to be 20-36 mm for both males and females respectively.

L. GUYOT [2003][20] Compared the reliability of direct clinical measurements versus the digital photogrammetric method to obtain clinical evidence of morphological abnormalities in patients with dysmorphic syndromes (22q11 microdeletion syndrome) and found statistical difference between two of the measurements on frontal views (ex-ex) & (en-en).

B.D.O. SAHEEB [2004][51] in a study done in a healthy population in Nigerians of age group 3-18 years provided a database of canthal measurements for a predominantly Black population and compared with Caucasians and found the values of Intercanthal distance to be significantly higher than Caucasians in both males and females.

S.M. BALAJI [2005][2] states that creation of optimal Intercanthal distance and contour of NOE valley is determined by medial canthal tendon and prudent soft tissue management.

ALAN.S.HERFORD [2005][1] in their study on Naso-orbito-ethmoidal fractures [NOE fractures] states that type III fractures are injuries with a comminuted central fragment with fractures extending to the bone bearing canthal insertion, according to Markowitz etal in 1991. In this study, all the patients possessing type III fractures with telecanthus were evaluated for Intercanthal distance postoperatively and narrowing of the distance was made surgically.

HASAN YASAN [2006][24] found no significant alteration in the dimensions of Interorbital distance by any effect of nasal polyp and chronic rhinosinusitis. The Intercanthal distance in the patients of the age group (34.49 $\pm$ 13.93), (Range: 18-76 yrs) were graded as grade 1, 2 and 3. The values for grades 1, 2 and 3 were $\leq$ 23mm, 24-29 mm, $\geq$ 30mm and most of the patients were in the grade 2 level.

JAYANTH KUNJUR [2006][29] in his study on anthropometric analysis of eyebrows and eyelids in three different racial groups of Whites, Indian & Chinese population states that Chinese men & women had wider Intercanthal distance of 37.2 mm for males and 36.4 mm for females than Indian and White population.

SAMUEL .L. LEONG [2006][50] in a study done at a Medical School, Scotland found the alar width to be significantly wider (3.6 cm) than the Intercanthal distance (3.0 cm). Compared to the Caucasians for whom it was found to be equal.

JAVAD FARIABY [2006][28] in a study done at the Medical University of Iran found the mean distance (in mm) between the two medial canthi to be 31 mm according to 2 D photography analysis and was less than the Europeans. (34 mm)

FARUK OZTURK [2006][14] in a Turkish study calculated the values of Intercanthal distance in Turkish population and found the values to be 30.7 mm in males and 30.2 mm in females.

R.WEBB [2007][58] advocates the use of a Willis bite gauge to measure the Intercanthal distance in the perspective of its significant role in assessment of midfacial trauma when telecanthus is suspected.

H.GHODDOUSI [2007][18] has done a study on assessing the difference between facial measurements by 3 means: (1) Manual measurements (2) 2D photographs (3) 3D Stereophotogrammetric method. Sliding calipers were used to measure the Intercanthal distance. Although there were differences, it was only marginal [only consistent error in the manual location of inner canthal point [avoiding direct contact].

WU CHOL SONG [2007][59] in his study on assessing horizontal asymmetries in young Korean adults concludes that each of the width related parameters with reference to eye and mouth were greater in males than in females [exocanthion width was the parameter with reference to eye].

CVICELOVA [2007][13] in a study done in a Medical University at Bratislova states that medial Intercanthal distance is equal to the eye fissure width in majority of men aged 22-25 years [21%] and was equal in only 3.33% of boys aged 7 years.

K. SUBASHRAJ [2OO7][54] in a retrospective study done at the Ramachandra Medical college, India for assessing the percentage of maxillofacial injuries has described the percentage of soft tissue injuries of maxillofacial trauma to be highest (42%) and was most highest in the age group of 21-30 years. [31%]

MOHAMMED ETEZAD-RAZAVI [2008][41] in studying an Iranian population found the values of inner Intercanthal distance for males in the age group of 71.7 $\pm$ 63.2 months to be 29.16 $\pm$ 3.31 mm and females in the age group of 98.8 $\pm$ 72.2 months to be 29.2 $\pm$ 3.4mm.

MEHMET BIROL UGUR [2008][38] in a study done in Turkey in healthy volunteers propogates medial canthus to be the reliable surface

landmark for identification of supratrochlear vascular pedicle in reconstructive surgeries with forehead flap.

MARIO .J. IMOLA [2008][36] in their study on secondary correction of post traumatic deformities imposes the importance of retaining the bony position of medial canthal tendon in transnasal fixation procedures and to prevent late telecanthus.

OYINBO CHARLES [2008][44] in a random study done in Nigerian population revealed the inner canthal distance measurements in young adults in Southern Nigeria to be 42 $\pm$ 5 mm, 39 $\pm$ 3mm for males and females respectively.

Maurice .Y. MOMMAERTES [2008][37] measures the interpupillary distance with the PM 600 digital pupillometer and proves it to be highly reliable both from the instrument measurements and from observer point of view.

OMAR .F. HUSEIN [2009][43] in an anthropometric facial digital photographic study found that the inner canthal distance in Indian American women was almost similar to the North American Whites and eyes were the most self liked feature among all facial features constituting for about 78%.

CHIARELLA SFORZA [2009][10] concluded the Intercanthal distance to be significantly larger in men than the women and aging had a profound influence on increment in soft tissue orbital area.

IRENE M.J. MATHIJSSEN [2010][26] has profounded certain guidelines for the reconstruction of the canthal ligaments to avoid telecanthus and maintain an intact lacrimal system and focusses on the use of full thickness grafts from upper eyelid for reconstruction of medial canthus.

I.S. GATAA [2010][16] in their collection of data regarding the pattern of maxillofacial injuries caused by terrorists attacks of Iraq, the most common age group of injured patients were between 15-29 years for males and 30-44 years for females. Isolated soft tissue injuries were most common and eye injuries constitute the highest percentage of maxillofacial injuries.

YAN DONG [2010][60] investigated the Intercanthal width through 3D anthropometry measuring apparatus and found the values to be 36.86 mm and 35.30 mm for males and females in Chinese population.

STATISTICAL METHODS

All variables, which include Intercanthal distance of male and female South Indian population, were assessed from the direct measurements made between inner canthus of right and left eyes. The datas obtained were tabulated and analyzed using SPSS: Statistical package for social sciences version II package. Descriptive statistics was used to determine the Mean and Standard Deviation. Differences between two measurements were tested with the independent t test. The level of significance used as $p<0.001$ was considered significant (S); $p>0.001$ was considered not significant (NS).

RESULTS :

Table I :

This indicates Intercanthal distance of male and female South Indian population. The mean amount of Intercanthal distance of male population was 32.8094mm, with a maximum of 39.58mm and minimum of 27.25mm. The mean amount of Intercanthal distance of female population was 31.4044mm, with a maximum of 38.66mm and minimum of 21.06mm.

Table II and Graph 3 :

This indicates mean difference between Intercanthal distance of male and female South Indian population. The mean difference was 1.40mm, which was statistically not significant; $p>0.001$.

Graph 1:

This shows distribution of samples in the range of values of Intercanthal Distance from 27.25mm to 39.58mm for males.

Graph 2:

This shows distribution of samples in the range of values of Intercanthal distance from 21.06mm to 38.66mm for females.

Table - I

Mean, Range and Standard deviation for values of ICD in Males and Females

	N	Minimum	Maximum	Mean	Std. Deviation
Males	301	27.25	39.58	32.8094	2.54665
Females	364	21.06	38.66	31.4044	2.67585

Table - II

Level of significance of Intercanthal distance values between males and females

Variables	Mean	Standard deviation	Level of Significance*
Males	32.8094	2.546	NS
Females	31.4044	2.675	NS

*p>0.001

NS - Non Significant

DISCUSSION

Visible facial disfigurement is a psychosocial disability[37]. However, beauty is in the eyes of the beholder (Hungerford, 1878)[37]. The assumption that people with extensive disfigurement are likely to have more problems than those with minor differences has no empirical support (Robinson, 1997). These assumed problems are due to feeling of reduced self esteem and body image (Koo and Young, 2002; Rumey, 2002). Eyes were the most self liked feature among the various features for about 78% (Omar .F Husein, 2009)[43]. Hence among the various features of aesthetic importance, inner Intercanthal distance plays a vital role.

Many artists (da Vinci, Durer, Armeneni, Cennini) surgeons (Gonzalez – Ullou, Lee, Powell) and Orthodontists (Ricketts, Merrifield) have proposed guidelines for drawing or evaluating facial aesthetics[40]. However, few have made clinical measurements of a large number of people to develop accurate guidelines for a more scientific aesthetic facial evaluation. Even though Farkas did make detailed anthropometric measurements of normal and attractive adults, his material is difficult to apply clinically because of the multitude of manuscripts in which he reported his data, and the fact that most of his publications are in clinical

journals. The orbits, situated between the cranial vault and face are a dominant aesthetic element in the craniofacial complex (Farkas and Kolar, 1987)[35], that greatly influences the visual judgements of healthy persons as well as those with facial deformities.

Farkas and his colleagues studied young North American White population but different ethnic subgroups within the same population group and found that although not much of the variation was found between intermediates, variation was found to occur between the extremes. This does not infer that these proportions should be used universally for all ethnic groups. For example, difference in nasal morphology is seen between Whites, Asians and Blacks. These indices must be used carefully in age groups other than young adults because of growth and aging with certain parameters but not all.

Intercanthal distance is an integral measurement in the evaluation of facial trauma, diagnosis of Craniofacial anomalies, and in the studies of orbito facial growth patterns. The aesthetic point of face lies in the position of the inner canthus which is the attachment of the medial canthal ligament to the bony orbit. The Intercanthal distance maintained by the ligament connects the tarsal plates and the palpebral structures to the median orbital structures.

The increase in the distance between the two medial canthi is known as telecanthus. Either it could be primary or secondary. Primary is due to the increase in the soft tissue width with a normal interpupillary and an interbony distance and is caused mainly by trauma. Secondary is a result of increase in the interpupillary and interbony distance with subsequent widening of the soft tissues.

Endocanthion, rather than the other soft tissue landmarks is a static and stable point because of its bony attachment to the medial orbit. Hence knowing the anatomy of the subcutaneous structures in this region especially the medial canthal ligament, a relevant anatomical feature in this study helps to delineate the normal case from the telecanthus case so that assessment becomes easier to compare with the normal norms for a specific population.

ANATOMY OF THE MEDIAL CANTHAL LIGAMENT (FIG. 5)

The inner canthus is a point where the medial ends of the upper and the lower eyelid margins unite. It is fixed in the depth of the naso-orbital valley by medial canthal ligament[50]. Medial canthal ligament is a band of fibrous tissue which acts as a tendon of insertion for the orbicularis oculi muscle. It is situated between the medial borders of the eyelids and the bones of the medial orbital wall viz, the lacrimal bone and the frontal process of the maxilla. The most lateral part of the medial canthal ligament are the upper and the lower palpebral extensions which attach to the margins of the tarsal plates lateral to the caruncle and delimit the inner canthus. (Fig. 7)

Medial canthal ligament consists of

1. Anterior limb
2. Posterior limb

Anterior Limb (Fig. 6)

Anterior Limb has a broad insertion to the frontal process of maxilla, palpable clinically and its lower border is visible through the skin. By virtue of the inherent strength of the anterior limb, breadth of

insertion, and the strength of the bones to which it attaches, the anterior limb provides the strong anchorage.

Posterior Limb (Fig. 6)

Posterior Limb consists of the lacrimal fascia and the areolar tissue. Extension of Orbicularis Oculi found in the posterior limb is Horner's muscle. The bone to which they are attached is very paper thin.

In trauma related to the NOE region, it is the pull of the orbicularies oculi muscle that pulls the medial canthal ligament and detaches it from the bony insertion, leading to the change in the position of the inner canthus and hence an increase in the width of the Intercanthal distance.

GROWTH OF ORBIT :

Abnormal development of one region of face may affect another (Enlow 1982) and in addition, irregularities of growth and shape in either the cranial vault or face will disturb the harmonious relationship between them and the orbits. Its important for a craniofacial surgeon to know the mean and standard deviations of key facial measurements at varying ages, the rates of growth of each facial region, the extent of growth completed at key age intervals and the times of maturation. Hence its essential to discuss the growth patterns of this region[35].

According to Zimmermann (1934)[11], the widely divergent embryonic position of the eyes gradually assumes the convergent appearance at birth. Post natal development of the bony interorbital distance is complex. Number of factors synchronously affects the interorbital distance.

- Early enlargement of the neurocranium with passive growth of the metopic suture
- Early growth at the fronto ethmoidal suture
- Anteroposterior cranial base growth at spheno ethmoidal and sphenofrontal sutures.
- Passive growth at the internasal and frontomaxillary sutures

❖ Bony apposition at the medial orbital walls.

According to (Ford, 1958)[11] increase in the interorbital distance resulted from the pneumatization of paranasal sinuses. In the functional matrix theory[11], the sinuses are interpreted as enlarging encapsulated spaces with interorbital growth being a secondary response.

According to Laestadius et al (1969)[23, 55], the growth curve of inner canthal distance rises only very slowly after 10-12 years, having already attained 78% of the adult measurement by 1 year of age.

According to Prema Lakshmi Narayana (1991)[45], the inner canthal distance rises rapidly from newborn to 3 years of age after which there is no rapid increase and found to be stable.

According to Morin (1963)[11], interorbital growth is 50% completed by the age of 3 years. According to Farkas (1992)[35], by the end of 1 year, the Intercanthal width reaches an advanced level in both sexes (84.1%). and by the end of 5 years (93.3%). Also rapid growth phase exists between the age group of 3-4 years. Males showed 55.4% of total growth increment and females showed 42.6% of total growth increment. Between the age group of 1-5 years, amount of growth occurring was slightly larger (3mm, 57.7%) and after 5 years, (2.2mm, 42.3%). The intercanthal width has reached the maturation completely by the age of 11

years for males and 8 years for females. This was coincident with the Scott's Study (1967)[35] and at the end by the age of 18 years, mean measurement were smaller by a fraction of a mm, that is 0.3mm for males and 0.5mm for females. Hence considering the fact that growth of the orbit is completed by the age of 10-11years, the sample group of age between 18-30 were selected in our study for establishing an ideal norm for Intercanthal distance.

With consideration in relation to eyeball and the orbit, the growth of the eyeball doesnot directly influence the size of the orbit. Eyeball grows independently in size in relation to orbit. It is about 75% of orbit in foetal stage and 32% of orbit in adulthood (Schultz, 1940), Dixon, Hoyte and Romming (1997). Eyeball grows rapidly during the first year and then expands slowly till 10-12 years, after which there is rapid growth until 20's [Saltzmann (1912), Weiss (1997)].

But orbital growth is completed 80% of adult size at the age of 3 years and 94% at 7 Years of age. Hence the variation which we find in individual samples is only due to soft tissue thickness between the bony orbit and the inner canthus and not due to the bony orbital growth. This can be understood from the measurements in cleft patients in a study done by Mustarde (1963)[23] who says that soft tissue layer is 2mm per canthus thicker in cases with 1cm larger inner canthal distance.

Several soft tissue variations in the medial canthal region may appear clinically as telecanthus, although medial canthal ligament is intact. These include epicanthus, vertical band of skin adjacent to bridge of nose overlying the medial canthus and general diminution of palpebral aperture. Skin folds running in the vicinity of the medial canthi was studied by Martin (1924)[11] who states that the epicanthal folds disappeared by the age of 11 in boys and girls. Though developmentally, these folds are universally present in foetal life from the third to the sixth, their presence would be in the nature of a tardy maturation rather than an actual abnormality. (Bolk, 1922)[41].

For a post-traumatic reconstructive surgery to be effective both aesthetically and functionally, the thickness of the soft tissue layer between the inner canthus and the anterior lacrimal crest was measured with the aim of correlating it to the Intercanthal distance and was about 5-7mm thick and moreover the ICD in cleft patients is higher than the normal (Hans Peter .M.F. Freihofer, 1980)[23].

In post traumatic reconstruction, the knowledge of the position of the medial canthal ligament as to whether it is detached or not decides the postoperative outcome. Eyelash traction test (Furnas and Bircill, 1973)[54] can be performed to know the attachment of medial canthal ligament and always essential to postpone the surgery until 6 months after after injury

to establish a normal Intercanthal distance. According to Stranc, the restoration of the normal intercanthal distance should take priority over the contours of the external nose in all nasal fractures with or without Lefort II[50].

Among the typical sequelae of the inadequately treated orbital injuries, telecanthus is one of the most prominent feature and one of the major ocular injury sustained after orbital fractures. Incorrect primary reconstruction due to malpositioned landmarks leads to shrinkage of inadequately supported soft tissues. The malpositioned soft tissue envelope needs to be completely mobilized and rearranged in a correct position and forms the basic elements of corrective surgery. Special attention has to be given to the medial canthal ligament because even minor malpositions are easily visible[4]. Mario .J Imola (2008)[36] signifies the importance of restoring soft tissue deformities since these are the most significant deterrents to achieving an ideal outcome.

According to Hanspeter .M. Freihofer, rather than primary reconstruction, the need for secondary reconstruction becomes more clinically significant in soft tissue deformities for a better aesthetic result. Since they have studied in population group of Netherlands, 33mm for direct and 31mm for indirect canthopexy was decided as the upper limit of distance after correction since these are considered to be ideal for

White population[22]. Also medial canthus being used as a point of surface landmark for locating supratrochlear artery in flap surgeries, implies its significance in plastic and reconstructive surgeries. (Mehmet Birol Ugur, 2008)[38]. Hence identification of standard norms for Intercanthal distance in a specific population becomes clinically significant in post traumatic reconstruction.

When diagnosing certain syndromes, abnormal facial features such as hypertelorism, low set ears, large ears, wide nasolabial distance etc are taken into consideration. More often, than not, the description is from a visual impression which may not be correct. Moreover, standards which have been available so far has been from North India except for one study from South India by Prema Lakshmi Narayana (1991)[45] whose measurements were not reliable due to 3 factors :

1. The use of simple transparent scale and possibility of error
2. Criteria of age group in his study was from birth – 11 years
3. Lack of explanation of growth pattern.

Our study gives a detailed description of the growth pattern and uses the digital calipers a reliable source of measurement which helps in distinguishing normal case from syndrome associated case.

Depending on the type of syndromes, the defect as to whether in soft tissue or hard tissue can be analyzed, and a necessary correction can be made by comparing the values of the normal population with that of the cases of anomalies or syndromes to establish a normal Intercanthal distance. Some of the syndromes related to the increase in the interorbital distance are Cleftlip/palate, (Moss et al, 1965), Waardenburg syndrome (Newton, 1989)[31], Frontonasal dysplasia, (Peterson et al, 1971) Craniofrontonasal dysplasia, (Saavedra et al, 1995) Apert syndrome, (Farkas et al, 1985), Crouzon syndrome, (Kreiborg, 1981). According to Hanspeter .M Freihofer[23], values of Innercanthal distance for normal males and females are 31.7 and 30.8mm which is close to values of Indian population and cleft patients had 33.4mm and 36mm respectively for males and females. Also in hypertelorism, the distance between Intercanthal width and bony interorbital distance were found to be 10.8mm, 11.5mm and 14.2mm in mild, moderate and severe cases which is significantly larger compared to normal cases which is about 5-7mm[34]. Hence it is significant to find ideal values for distinguishing from syndrome associated cases.

According to Ellis, Intercanthal distance is half of that of the interpupillary distance, but in case of extensive facial trauma, orbit and orbital contents may have disturbed those proportions precluding the use

of this parameter[39]. Hence, it's better to use standard values for Intercanthal distance independently of age and sex.

daVinci divided the head horizontally into fifths by the endocanthions and exocanthions at the orbital level. Farkas found these landmarks to be useful subdivision points for comparison[40]. Hence endocanthion, the point of reference for Intercanthal distance in our study gains significance.

Prema Lakshmi Narayana (1991)[45] in her study on Intercanthal distance in South Indian population uses a modified transparent scale for measuring the inner and outer canthal dimensions which could create a measurement error of $\pm$ 1mm which is very significant in establishing a proper aesthetic soft tissue landmark. Hence we advocate the use of the a digimatic vernier caliper with a resolution of $\pm$ 0.01mm and the instrument error is only $\pm$ 0.02mm. The maximum inner canthal dimensions was obtained as 3.1cm at 5 years of age after which there was no further growth and was stable.

Arriving at the difference between the different population groups, Saheeb (2004)[51], in his study on Nigerian population in the age group of 3-18years, found the values of Intercanthal distance to be significantly higher than the Caucasians and the mean value was about 3.59cm for

males and 3.13cm or females and in another study in the same population by Oyinbo A. Charles (2008)[44] revealed 42 $\pm$ 5 and 39 $\pm$ 3mm as Intercanthal measurements in males and females respectively.

Also the Chinese population showed maximum values of Intercanthal distance of about 36.86mm for males and 35.30mm for females than Indians and the Whites (Yan Dong, 2010)[60]. According to Brett .J King (2003)[5], Asian population had wider Intercanthal distance of 35.6mm followed by Hispanic, African – American and Caucasian population. But however, Indian population, a developing Asian population shows an average value of 31-32mm which is comparatively less compared to the overall Asian population. Also, our study shows more number of samples being distributed in the range of 32mm for males and 31mm for females which can be seen in Graph 1 and 2.

In individuals with trauma, a method to accurately determine the preinjury distance has been putforth by Edward Ellis (1991)[55] who states that normative values cannot be used for everyone because differences in age, sex, race and individuals occur. He advocated the use of preinjury photographs and calculate the Intercanthal distance by a formula

$$\text{ICD (actual)} = \frac{\text{ICD (Photo)} \times \text{REF Object (actual)}}{\text{REF Object (Photo)}}$$

However, in cases with no photographs, the values formulated from our study in relation to age and sex might provide an useful, standard norm for the specific population.

In the study by Jairup Singh, Sarla Bannerjee (1983)[27], the mean values for Intercanthal distance was measured by sliding calipers. The values were 3.15 $\pm$ 0.2445cm and 3.09 $\pm$ 0.2862cm for males and females respectively. But this study was not specifically related to South India and hence forth the selection of this group of population in this study. But even South Indian population shows almost similar values of North Indian population which can be shown in Table 1.

Measurement with the help of an anthropometric ruler is not found to be highly reliable in another study done by Maurice .Y Mommaerts (2008)[37]. In a study done in Iran by Mohammed Etezad – Razavi (2008)[41], translucent plastic ruler has been used for measurement of inner Intercanthal distance. A non-stretchable plastic ruler was used by Cem Everekliogl (2001)[8].

Ward and Jamison evaluated the precision and reliability of linear anthropometric measurements and in no case did separate measurements

differ by more than 4%. However linear measurements of small magnitude and difficulty in identifying landmarks which according to them would produce a greater percent of deviation. The least reliable distances were phitral width, nasal root width, columella width and nasal protrusion. But the parameter of Intercanthal distance is not included in this least reliable category. But he focuses on the conversion of these linear values into proportions and rounded off for homogeneity and ease of usage and precluding errors. Considering all these facts, we advocate the use of digital caliper with a resolution of 0.01mm and a measurement error of $\pm$ 0.02mm, through which a very reliable and acceptable measurements are made in our study.

In clinical practice, when measuring soft tissues, calipers are placed without structural distortion, to provide a measurement without error[40].

Osuobeni (1994)[44] on studying a group of Arabs used photogrammetric method of measuring facial distances but was fraught with technical errors. Hence he suggests the use of clinical measurements since its simple to use for standard clinical workups in clinical genetics as long as racial standards values are used.

Another study by Pandey (1983)[19] in Indian population done in the age group of 3-80 years for measuring Intercanthal distance was done with a millimeter scale and was found to be 20-36mm for both males and females. The error with this method of measurement could be $\pm$ 1mm, which is not reliable. In a study by Guyot (2003)[20] for assessing the clinical and photogrammetric method of measuring distances in a group samples of 22q11 microdeletion syndrome, Photogrammetric method of assessing distances yielded acceptable measurements only in profile views but not on frontal views. Hence only clinical measurements has proven to be reliable in their study for frontal measurements. Fortunately, the Intercanthal distance, the parameter in our study is one of the frontal view parameters, hence we use digimatic vernier caliper for our clinical measurements.

Javad Fariaby (2006)[28] signifies the importance of patients photographs (2D measurement) in orthognathic and rhinoplastic surgeries and has given the values for men and women to be 32mm and 30mm. But digital vernier caliper gives an accurate and precise measurement of the distance than the photographic analysis which is precise only when the distance measured between two points are in the same plane.

Webb (2007)[58], proposes the use of Willis bite gauge to measure the inner canthal distance but not precise to the level of a digital caliper.

Guyot (2003)[20] says that correlation between the direct and photogrammetric measurements was better on profile than frontal views. The reason behind this is that in theory, all previous studies used undefined external scales for measurements. But this is reliable only for certain parameters where the points are located in the same plane. But this is not so with Intercanthal distance because of the presence of bridge of nose. The same holds true for photography even. Hence even digital photogrammetric method of measuring Intercanthal distance is not applicable. Hence we precluded the use of measuring scales and focused on the use of digital calipers which doesn't incorporate errors in the measurements. This is because eventhough if points are located in different planes, the external jaws of the calipers assumes them to the same plane thereby avoiding bias in the values.

In a pattern of study of maxillofacial injuries due to road crashes in Chennai, (Subash Raj etal, 2007)[54] soft tissue injuries retained the highest group of injuries (42%) and the percentage of injuries among the age group of 21-30 years were the highest because of the predominance of men and women in the 20-29 year old age group and the male : female ratio was 3.7:1[54, 12]. Hence we have chosen the age criteria for our study to be 21-30 years.

In a study by Ghodoussi etal (2007)[18] while comparing the manual, 2D and 3D measurements, manual measurements were made using sliding and spreading calipers, 2D with 2:1 megapixels (Sony Cybershot) digital camera and 3D with equipment (Minolta Vivid 900), Osaka, Japan. But the high cost of equipment and the need for a proper standard setup which might not be available in all instances, promoted us to the use of simple, cost - effective means of measurement, THE DIGIMATIC VERNIER CALIPER with very minimal errors.

SUMMARY AND CONCLUSION :

Biological vertebrates develop in a generally symmetrical pattern but the basic design of the two composite halves is sometimes modified partially during growth and development such that various degrees of asymmetry develop in different organs and structures. Structural asymmetry can be altered by function, trauma or disease.

Since any change in the Intercanthal distance is an important diagnostic sign in several syndromes associated with craniofacial abnormality, the clinical measurements are usually compared to a normal value. Any variation in the cranial size and shape or orbital size and shape means that comparison must be made with values for a given age, population group and sex.

Successful treatment of patients with complex injuries of craniofacial trauma depends on the precise clinical evaluation to establish a three dimensional configuration of the fractured segment and application of well established principles of fracture repair. Intercanthal distance the distance solely dependent on the point of endocanthion which is the point of attachment of medial canthal tendon plays a significant role in trauma reconstruction for which our values proves to be significant.

In our study we could find a major variation in the Intercanthal distance between the Indians and Chinese population. Also the distance is wider in Nigerians than the Indians showing distinct variation in the population.

Our study is dealt with an adult population taking into consideration the frequency of trauma in South India. Also the Black population is no more a homogenous group that the White population is no more a homogenous group than the White population. Each has numerous subpopulations containing phenotypes. Taking this into consideration, the data from this study still provide some guidance in the making of clinical determinations. Knowledge of the differences between the soft tissue and the skeletal orbital measurements is very much useful for preoperative planning. The satisfaction of the patients depends upon the restoration of the harmony between the orbits and the face and not solely on the quality of the skeletal changes. Hence the point of endocanthion (en) the point of attachment of the medial canthal ligament, a precise landmark from aesthetic point of view, a sole decision maker of the resultant aesthetic effect, gains much importance in the correction of improper Intercanthal distance.

To conclude, the parameter of Intercanthal distance in South Indian population has least variation between males and females and the results are insignificant by the study.

As Farkas said, these values are an attempt to take the subjective nature out of facial evaluation and should be used as a guide to evaluate disharmony. Bringing more of these values closer to the normal mean may produce harmony and thus attractiveness. An attractive feature should not be altered simply because it deviates from a proportion is a saying… But still Intercanthal distance is a significant parameter in soft tissue oriented surgeries around the medial side of the orbit.

"PERSONAL BEAUTY IS A BETTER INTRODUCTION THAN ANY LETTER"

The importance of elucidating modern concepts of facial beauty is becoming increasingly understood by this study. Perhaps, Ralph Walde Emerson (known as the first American to Champion the wisdom of ancient India) summed it up best when he said,

"IF EYES WERE MADE FOR SEEING, THEN BEAUTY IS ITS OWN EXCUSE FOR BEING"[43].

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Fig.5. ***Anatomy of the Medial Canthal ligament***

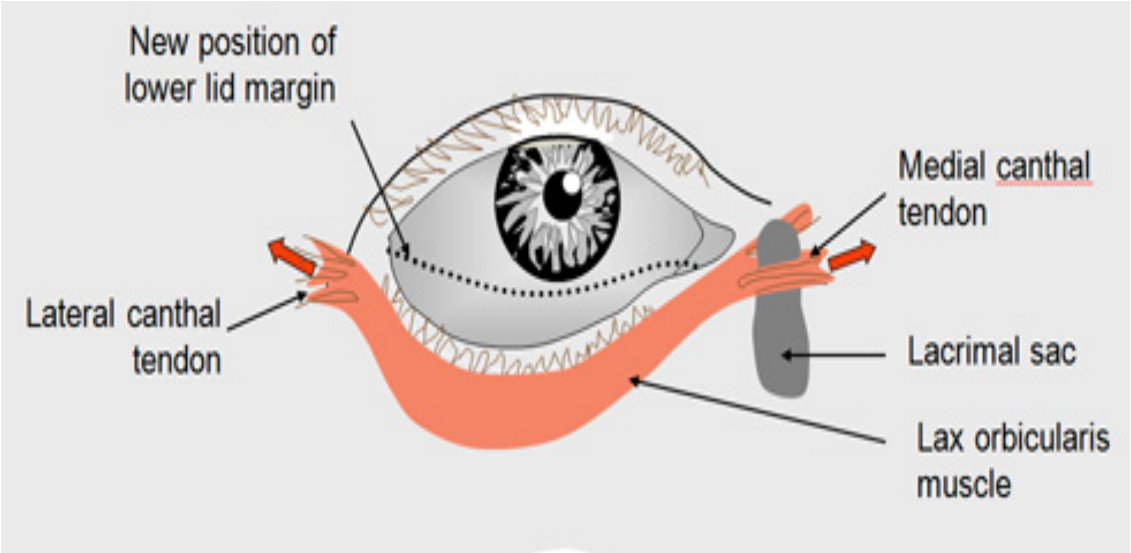

Fig.6. Parts of a Medial Canthal ligament

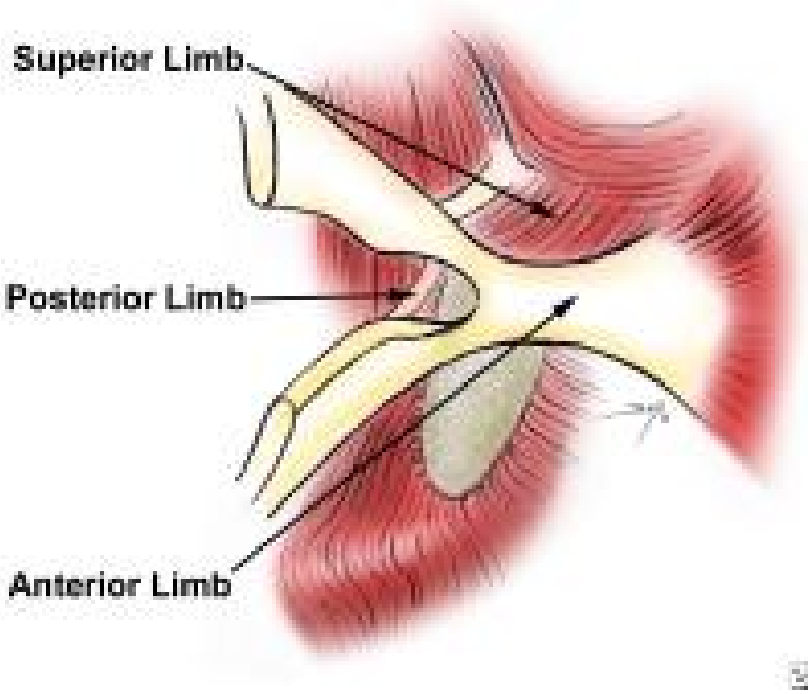

Fig.7. ***Attachments of the Medial Canthal ligament***

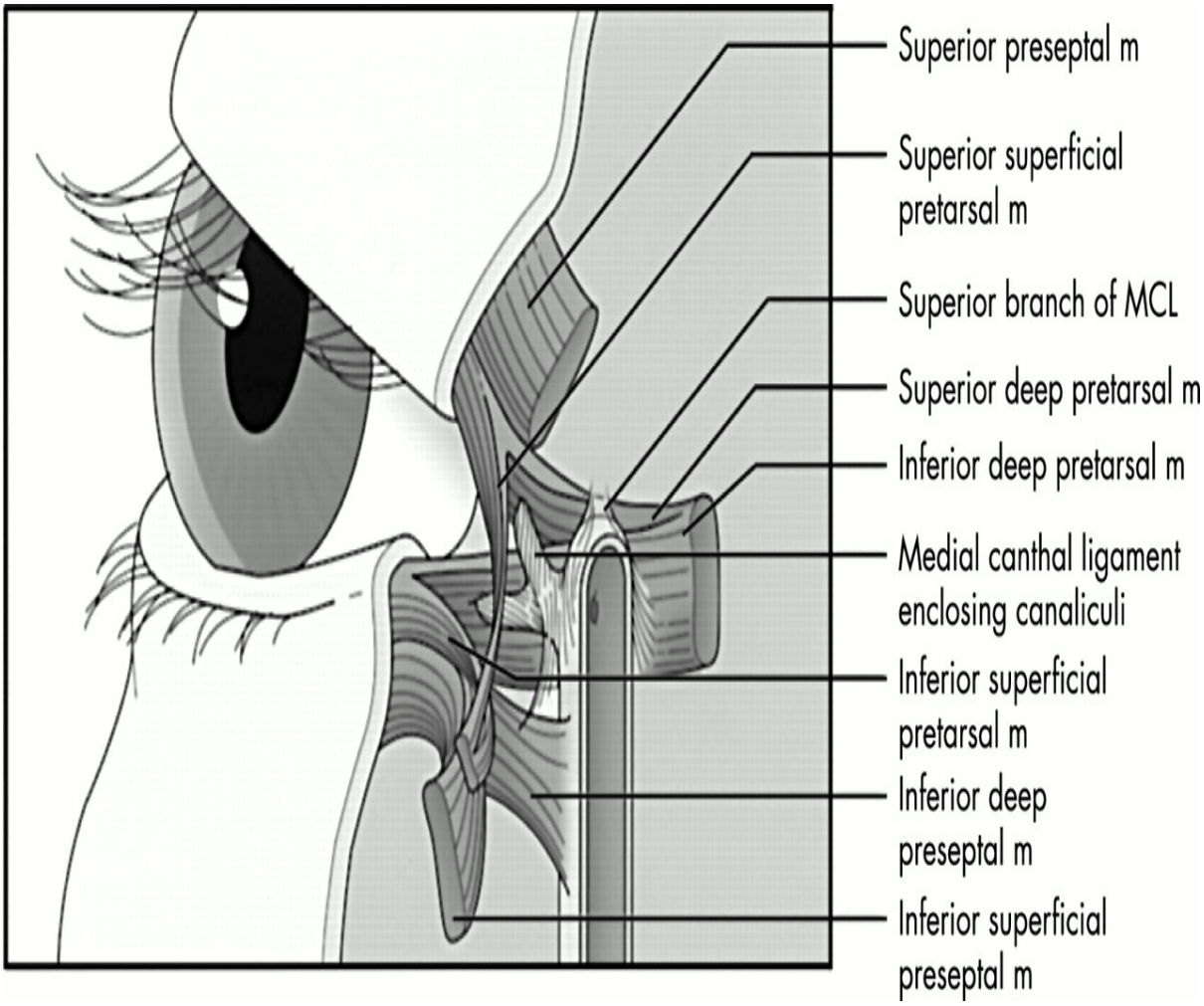

Fig.1. Digimatic Vernier Caliper

Fig.2. LCD Display of the Digital Vernier Caliper

Fig.3. Method of Measurement (Frontal view)

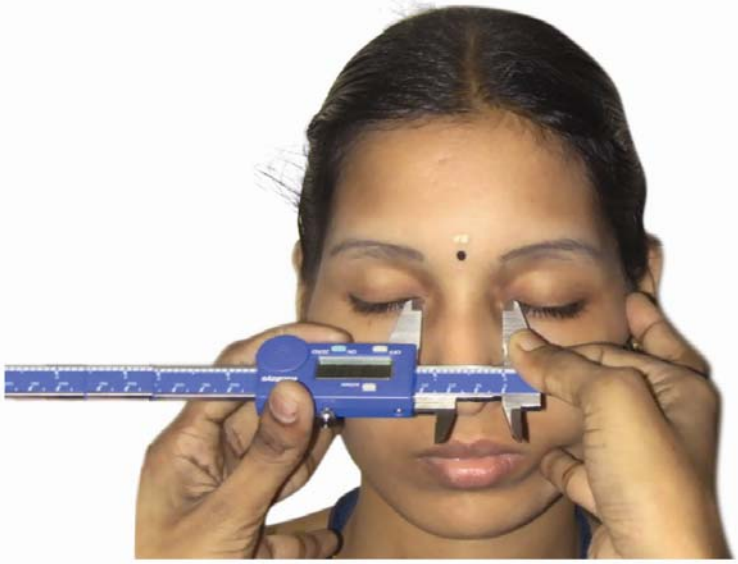

Fig. 4. Method of Measurement (Aerial view)